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AUTHOR Fishburne, Robert Purdy, Jr.
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ABSTRACT

Pupil learning about evolution under different types of instruction is examined. A branching style program in which written responses were required was compared with a program in which the same material was presented in straight narrative style. The project compiled and analyzed test results from 115 fifth-grade students. The students were divided into two groups, one of which was assigned a programmed text on evolution; the other was assigned a parallel narrative version. Results from a posttest and retention test indicated the programmed text to be significantly superior to the nonprogrammed text in teaching elementary school students about evolution. The results of a questionnaire on attitudes of the children toward presentation of the material on evolution indicated that they viewed both texts favorably, with slightly greater preference for the programmed text. The author concludes that the overall favorable attitude of the students to both texts could possibly be attributed to a novel approach. Tables and references on works relating to programmed instruction, audiovisual communication, and learning processes are included. (Author/DB)

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A COMPARISON OF A PROGRAMMED AND A NON-PROGRAMMED TEXT ON EVOLUTION FOR THE FIFTH GRADE

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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by

Robert Purdy Fishburne, Jr.

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Approved by

Committee:

Geo. N. Thomas
Major Professor

Department Head

CHAirman of Division

Dean, Graduate School

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The programmed text Evolution by Dr. Georgelle Thomas, and the parallel narrative version, were adapted from Chapter II, "Evolution," Development of Man and His Culture: Old World Prehistory by Marion J. Rice, Publication No. 31, Anthropology Curriculum Project, March, 1966.

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Attention to programmed learning began with the introduction of the teaching machine as a technological aid. The first of these machines was developed by Sidney L. Pressey (1926) as a self scoring device to facilitate the taking and scoring of objective examinations. The student read the question presented in the aperture of the machine, selected an answer from among several alternatives, and then pressed the button corresponding to this chosen answer. If he was correct, the next question appeared in the slot; if he had made a mistake, the original question remained. The machine counted his errors, but the tape did not move on to the next question until the right button had been pressed. Because the student knew that he was correct when the question moved, he had immediate feedback or reinforcement and thus learned while testing himself. In most respects Pressey's machine had the same capabilities as the machines now in use. Yet despite the promise of his experimental results (Pressey, 1932) the movement in behalf of such devices lost its impetus. There are at least two explanations for this. First, no provision was made for systematic programming of materials to be used in these machines, and, second, the onset of the depression offered an

unfavorable environment for introduction into the nation's schools (Lysaught & Williams, 1963). Because of these conditions, no new research of importance in programmed instruction was reported until the 1950's.

The publication of a paper by B. F. Skinner (1954) began the research and development of programmed instruction which has continued to the present. Skinner developed a machine which differed from Pressey's chiefly in that the student was not given alternatives to choose from, but instead was asked to write his own responses in the spaces provided, and then, as a printed tape advanced, the correct answer appeared for comparison with what he had written. The use of small steps from simple to complex material assured a high probability of the student's response being correct and thus reinforced by the comparison response. A further difference between the Pressey and Skinner devices is that the Skinner material is so planned that it is not essentially a review of partially learned material, but rather a "program" in which the responses of the learner are shaped as he learns.

Far more complex instructional devices have been developed beyond that of Pressey and the one first designed by Skinner. Many of these machines have been developed by the United States Air Force. Lumsdaine (1959), who had a prominent role in their development, has given a description of many of them.

The essence of learning by means of a teaching machine lies not in the machinery, but in the material to be presented; and it has been found that properly designed programmed books can serve about the same purpose as the simpler forms of teaching machines. Programmed books such as Holland and Skinner's The Analysis of Behavior (1961) are now available on a wide range of subjects.

Since a program is designed to do the teaching without the aid of an instructor or other support, it necessarily must begin with what the learner already knows. This knowledge or prior learning is added to by eliciting answers that are at first hinted at or prompted in order to make the correct answers highly probable. These answers, once reinforced are then overlearned through their repeated use as a new material is added.

There are two basic types of programs. The type advocated by Skinner is called the linear program. The program initially asks the student questions which he can easily answer. It then proceeds through a predetermined sequence of questions or "frames" which require him to construct his own responses. Less and less "prompting" is provided as he progresses in very small steps through the program.

The second type of program is the intrinsic or

branching program developed by Norman Crowder (1959). This consists of a series of sequential subject matter units followed by multiple choice questions. The student is provided with additional material on the basis of his response. If he is correct new material is provided. If he selects the wrong answer, he is directed to a review page which has a more detailed explanation of the same material.

The linear and the branching programs are by no means the only programs now in existence. There have been numerous modifications of these basic styles. Many of the more recent programs make use of branching within a linear program.

The extensive research which has been done on programmed instruction has demonstrated that students do learn from programmed instruction, but the question of how well students learn from programs as compared to other kinds of instructions cannot be answered with as much confidence.

One of the areas of research in programmed learning has been concerned with a comparison of learning from programs with learning from conventional texts. An essential hypothesis to be treated in this particular area is whether or not the overt responding, which is the essence of the program, has a significant effect on learning. Studies comparing the practice of active response versus the mere reading of items with the responses filled in are somewhat

equivocal. Holland (1960) using psychology as the subject material found that a group which merely read complete statements made more errors than either active or covert responders on a final test, but also took less time to complete the program. Senter (1966) compared three methods of instruction in binary and octal arithmetic: Norman Crowder's branched programmed text (1962), another modified version of this programmed text, and a narrative text version presenting the same content material. Both of the programmed instructional methods resulted in significantly greater performance on the criterion test than was obtained by using the narrative text. Silberman (1962) in his summary of 15 studies comparing programmed texts with narrative texts reported that 9 studies reported superior learning for the programmed materials and 6 reported no difference. Krumboltz and Wersman (1962) found no significant difference on immediate posttest scores between a group using a regular programmed text and another group using a programmed text with all blanks filled in. A two week delayed retention test, however, did show significance in favor of the programmed text requiring overt responding. A similar study by Crist (1966) examined the effects of overt versus covert responding on retention by sixth grade students using two programmed texts on astronomy. On the immediate posttests there were slight but nonsignificant differences between the overt and covert

responding groups. On a two week delayed test the slight differences did not occur, and the mean covert and overt scores were almost identical. Roderick and Anderson (1968) compared a programmed introduction to psychology with a text-book style summary of the same lesson. Overall, the high school and college students who completed the program scored higher on a posttest than those who studied the summary. The advantage of the program was greatest with high school students.

The present study involved a comparison of a branching style program in which active responding (writing of responses) was required with the same material presented in straight narrative style. A programmed text on evolution (Thomas, 1971) for fifth grade children was created from subject matter provided by "The Anthropology Curriculum Project" of the University of Georgia. A parallel narrative version of the text was derived directly from the programmed text for use in this study.

The experimental hypotheses to be tested were:

1. That the programmed text group will score significantly higher than the parallel narrative text group on the posttest.
2. That the programmed text group will score significantly higher than the parallel narrative text group on gain scores from pretest to posttest.

3. That the programmed text group will score significantly higher than the parallel narrative text group on gain scores from pretest to retention test.
4. That the programmed text group will require significantly more time than the parallel narrative text group to complete their text.
5. That the programmed text group will give a higher percentage of favorable responses than the parallel narrative text group to the text evaluation questionnaire.

METHOD

Subjects

The 115 subjects consisted of four classes of fifth grade children at Sallie Zetterower Elementary School in Statesboro, Georgia. Two classes (54 students) were randomly assigned to receive instruction by the programmed text on evolution (programmed group) and the remaining two classes (42 students) to receive instruction by the parallel narrative version (non-programmed group). All classes consisted of both white and black, male and female children.

Materials

The materials consisted of copies of a programmed text on evolution for fifth grade children, copies of a parallel version of the programmed text, copies of a Pronunciation Guide, and a pronunciation tape for use on a tape recorder. All printed materials were reproduced in pica 72 type by offset press. The programmed text (Appendix A) was written in the branching style and required written responding from the subject. The parallel version (Appendix B) presented the same material with all blanks filled in. The branching pages for incorrect answers in the programmed text

were removed in the parallel version, but all other review material was kept equal. The Pronunciation Guide (Appendix C) and pronunciation tape were composed of pertinent words presented in both texts. The 21 words printed on separate pages were divided into syllables and marked for accent. The voice on the tape pronounced each word twice and then provided an opportunity for the students to pronounce the word.

Two forms of a matching type evaluation test, Form A and Form B (Appendices D and E), were also developed for use with both groups. Test items were matched for equal difficulty on both tests.

A seven question pupil evaluation survey was designed to obtain an objective quantification of student opinion. This survey was attached to Test Form B (Appendix E).

Procedure

For four days of the week prior to receiving the texts subjects in both groups listened to the pronunciation tape and actively responded to it while looking at their own Pronunciation Guide book. Tape playing time involved six minutes each day. The classroom teacher was instructed not to explain any of the words to the children.

On the fifth day of that week a pretest (Form A) was administered to determine if the programmed and non-programmed groups differed in prior knowledge of the

evolutionary concepts.

For four days of the following week all subjects in all classes were allowed to go through their assigned programmed or parallel narrative book at their own speed. A record was kept of the working times for each subject. The experimenter was present at all classes to supervise the sessions.

On the fifth day of that week a posttest (Form B) was administered. A student evaluation form was attached to the posttest.

Two weeks from the day of the posttest a retention test was administered (Form A) to all subjects.

The California Reading Test (Form W) had been administered approximately eight months prior to this study as a routine school policy. Reading level scores were thus obtained for all subjects to determine if the two groups had comparable reading skill.

RESULTS

Table 1 shows the group mean scores and standard deviations for the programmed and non-programmed text groups on the California Reading Test and the pretest (Evolution-Form A). The programmed group had a reading level of 5.9, while the non-programmed group had a reading level of 5.7. This difference was not significant at the .05 level (t = .549). On the pretest (Evolution-Form A), the programmed group had a mean of 7.0, while the non-programmed group had a mean of 7.3. This difference was not significant either (t = .409, $p > .05$). Thus it was assumed that there was no difference between the programmed text group and the non-programmed text group on prior knowledge of evolution or on reading ability.

Table 2 presents the source table for a two factor analysis of variance performed on the posttest scores. Factor A consisted of the programmed vs. non-programmed conditions and factor B consisted of three reading levels. The California Reading Test levels which divided those students scoring below 4.5 and those scoring above 5.5 from the 4.5 to 5.5 range, evaluated the effect of reading ability on the test performance of the two text groups. The completely

TABLE 1

Means and Standard Deviations of California Reading Test (Form W) and Pretest (Form A) Scores

	California Reading Test		Pretest	
	Mean	Standard Deviation	Mean	Standard Deviation
Programmed Group	5.851	1.967	7.037	3.018
Non-Programmed Group	5.657	1.505	7.309	3.342

TABLE 2

Analysis of Variance Table for Posttest Scores and Reading Level

Source	SS	df	MS	F	P
Text (A)	147.407	1	147.407	8.544	.01
Reading Level (B)	1270.779	2	635.389	36.829	.01
A x B	1.681	2	.840	.048	
W Cell	1552.70	90	17.252		

randomized factorial design with an unweighted mean analysis for unequal n's (Kirk, 1968) yielded a significant difference between the programmed and non-programmed groups ($F = 8.544$, $p < .01$) and reading levels ($F = 30.829$, $p. < .01$). There was no significant interaction between reading levels and the programmed and non-programmed text groups.

In Table 3 are presented the posttest gain score means (posttest minus pretest scores) and the two week delayed retention test gain score means (retention test minus pretest scores) for the programmed and non-programmed groups. The programmed text group had a mean posttest gain score of 9.2, while the non-programmed group had a mean gain score of 6.1. This difference was significant beyond the .01 level ($t = 3.694$). On the retention test the programmed group had a mean gain score of 6.6, while the non-programmed group had a gain score mean of 4.5. This difference was significant beyond the .01 level also ($t = 2.828$).

Time scores for completion of the programmed and the non-programmed text are presented in Table 4. The mean time for completion of the programmed text was 118.8 minutes, while the mean time for the non-programmed group was 52.2 minutes. This difference is significant beyond the .01 level ($t = 15.568$).

The results of the student questionnaire responses

are presented in Tables 5, 6, 7, 8, 9, 10, and 11. The Pronunciation Guides and tape recording presentations which were utilized prior to the text study sessions were judged by the fifth grade children to be helpful. Seventy-one percent of the programmed group and 84.4% of the non-programmed group reported that "it helped a lot." On the question concerning how much difficulty was encountered following directions in the texts, 58% of the programmed group reported "no trouble," while 75.8% of the non-programmed group reported "no trouble." Table 7 presents the results of the question concerning whether or not the students enjoyed the text on evolution; 78.8% of the programmed group and 75.8% of the non-programmed group "liked it very much." Table 8 gives the results of the responses to the question concerning how difficult the text was to understand; 69.7% of the programmed group reported that "it was a little hard" as did 63.6% of the non-programmed group. None of the students in either group reported that "it was hard." Table 9 presents the data from the question of whether or not the students preferred their text to a teacher; 86.6% of the programmed group and 60.6% of the non-programmed group said "yes." The data concerning the question of whether or not the students believed they learned more from their text on evolution than from a regular text is presented in Table 10; 90.4% of the

TAPLE 3

Means and Standard Deviations of Posttest and Retention Test Gain Scores

	Posttest Gain		Retention Test Gain	
	Mean	Standard Deviation	Mean	Standard Deviation
Programmed Group	9.2	3.912	6.611	4.04
Non-Programmed Group	6.1	4.126	4.523	3.146

TABLE 4

Number of Minutes Required for Completion of Programmed and Non-Programmed Text

	Time (minutes) to Completion of Text	
	Mean	Standard Deviation
Programmed Group	118.78	27.48
Non-Programmed Group	52.24	12.86

TABLE 5

How much did the pronunciation guide and the tape recording help you learn the words in this book?

	It did not help	It helped a little	It helped a lot
Programmed Group	3.2%	25.8%	71%
Non-Programmed Group	6.2%	9.4%	84.4%

TABLE 6

How much trouble did you have following directions in your book?

	I had no trouble	I had a little trouble	I had a lot of trouble
Programmed Group	58%	39.7%	3.3%
Non-Programmed Group	75.8%	24.2%	0%

TABLE 7

Did you enjoy your book on evolution?

	I did not like it	It was all right	I liked it very much
Programmed Group	3%	18.2%	78.8%
Non-Programmed Group	6%	18.2%	75.8%

TABLE 8

How difficult was your book for you to understand?

	It was easy	It was a little hard	It was hard
Programmed Group	30.3%	69.7%	0%
Non-Programmed Group	36.4%	63.6%	0%

TABLE 9

Would you rather learn from a book like the one you just read than from a teacher?

	Yes	No
Programmed Group	86.6%	13.4%
Non-Programmed Group	60.6%	39.4%

TABLE 10

Did you learn more from reading your book on evolution than from reading a regular book?

	Yes	No
Programmed Group	90.4%	9.6%
Non-Programmed Group	97%	3%

TABLE 11

How much do you think you know about evolution?

	I do not understand evolution	I know a little about evolution	I know a great deal about evolution
Programmed Group	3.2%	54.8%	42%
Non-Programmed Group	0%	60.6%	39.4%

programmed group and 97% of the non-programmed group said "yes." Table 11 presents the results to the question which asks how much the students think they know about evolution; 54.8% of the programmed group reported they knew "a little," while 42% reported they knew "a great deal" about evolution. In the non-programmed group 60.6% of the students reported that they knew "a little," while 39.4% reported that they knew "a great deal" about evolution.

DISCUSSION

Comparison of the performance of the programmed text group with the non-programmed text group revealed significantly greater learning for the programmed text group. The superiority of the programmed text group on the posttest was in accord with the findings of Senter (1966). The analysis of variance results indicated that reading level did have a significant effect, but that there was no interaction between reading level and programmed or non-programmed text. As would be expected, the better reader learned more material and thus performed better on the posttest. The identical content of the programmed and non-programmed texts would lead us to expect that there would be no interaction with reading level.

The retention test results paralleled those of Krumboltz and Wersman (1962) in that the programmed text group performed significantly better. The statistical results from the posttest, gain scores, and retention tests all provide more evidence in favor of the programmed text and overt responding to be weighed against equally impressive findings to the contrary in other studies (Silberman, 1962).

The only disadvantage observed with the programmed text was in the time required for its use. The non-programmed text required less than half the time that the programmed text required for completion. This finding, of course, would be expected in view of the fact that the programmed text necessitated written responses and had 28 additional "branching" pages. However, the presentation of the material and the amount of review was held constant in both texts, with the exception of the "wrong answer" pages (e.g., See page 2 of Appendix A). These pages were deleted from the non-programmed text since there was no opportunity for subjects to respond and thus possibly make errors. This omission from the non-programmed text only accounts for eight pages. The primary reason for the size difference is in the inclusion of instructions and space for responding in the programmed text. The "right answer" confirmation pages were included in the non-programmed text as a review. Thus the extra time required for the programmed text can primarily be accounted for in terms of the overt responding. The time disadvantage of the programmed text must be weighed against the superiority in test performance. The fact that the students using programmed texts were exposed to the material for a longer time cannot be overlooked; it is possible that this longer exposure was responsible for their better test performance.

Although the programmed text has been shown to be significantly superior to the non-programmed text, it should be noted that test score means were rather low in both groups. The programmed text group for example had a mean score of 16.2 on the posttest, while the non-programmed group had a mean of 13.3 out of 26 possible correct responses. Possible explanations for this could be in the construction of the tests or in the lack of student motivation. One factor which could possibly account for test difficulty is the use of single spacing for the questions. Fifth grade literature is traditionally printed with large type and with greater spacing. The absence of the usual grade incentive in the classroom could account for a lack of motivation to achieve.

The results of the student questionnaire indicate that the students viewed both texts favorably, with indications of a slightly greater preference for the programmed text. The overall favorable attitude of the students to both texts could possibly be attributed to a novelty effect.

The Pronunciation Guides and tape recording were used in this study as an aid to learning. The purpose was to help the students become familiar with some of the difficult words and to generate enthusiasm for their programmed

or non-programmed text. The only measure of its value obtained in this study was from student responses. Student questionnaire results indicated that the Pronunciation Guides were helpful.

Looking at the programmed text, we can see not only that it is superior to the non-programmed text, but that it is viewed favorably by fifth grade students.

SUMMARY

115 students comprising four classes of the fifth grade were divided into two groups according to class. Two classes were assigned a programmed text on Evolution and the remaining two were assigned a parallel narrative version. The programmed text was written in the branching style and required overt (written) responding from the subject. The parallel narrative version presented the same material, but required no written responding. Results from a posttest and a retention test showed the programmed text to be significantly superior to the non-programmed text. The results of the questionnaire reflected favorably upon the presentation of the material on evolution, with indications of slightly more favorable responses from the programmed text group.

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